SEQUENCE LISTING

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<110> Chiang, Vincent Lee C.
      Tsai, Chung-Jui
      Hu, Wen-Jing

<120> GENETIC ENGINEERING OF LIGNIN BIOSYNTHESIS IN PLANTS

<130> 66040-9651

<140> 09/530,663
<141> 2000-07-11

<150> PCT/US98/24138
<151> 1998-11-12

<150> 08/969,046
<151> 1997-11-12

<160> 17

<170> Word 97 (DOS text format)

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<213> Populus tremuloides Michx. (aspen)

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                        Met Asn Pro Gln Glu Phe Ile Phe Arg Ser
                         1               5                   10

aaa tta cca gac atc tac atc ccg aaa aac ctt ccc ctg cat tca tac     160
Lys Leu Pro Asp Ile Tyr Ile Pro Lys Asn Leu Pro Leu His Ser Tyr
                15                  20                  25

gtt ctt gag aac ttg tct aaa cat tca tca aaa cct tgc ctg ata aat     208
Val Leu Glu Asn Leu Ser Lys His Ser Ser Lys Pro Cys Leu Ile Asn
            30                  35                  40

ggc gcg aat gga gat gtc tac acc tat gct gat gtt gag ctc aca gca     256
Gly Ala Asn Gly Asp Val Tyr Thr Tyr Ala Asp Val Glu Leu Thr Ala
        45                  50                  55

aga aga gtt gct tct ggt ctg aac aag att ggt att caa caa ggt gac     304
Arg Arg Val Ala Ser Gly Leu Asn Lys Ile Gly Ile Gln Gln Gly Asp
    60                  65                  70

gtg atc atg ctc ttc cta cca agt tca cct gaa ttc gtg ctt gct ttc     352
Val Ile Met Leu Phe Leu Pro Ser Ser Pro Glu Phe Val Leu Ala Phe
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cta ggc gct tca cac aga ggt gcc atg atc act gct gcc aat cct ttc    400
Leu Gly Ala Ser His Arg Gly Ala Met Ile Thr Ala Ala Asn Pro Phe
                95                  100                 105

tcc acc cct gca gag cta gca aaa cat gcc aag gcc tcg aga gca aag    448
Ser Thr Pro Ala Glu Leu Ala Lys His Ala Lys Ala Ser Arg Ala Lys
            110                 115                 120

ctt ctg ata aca cag gct tgt tac tac gag aag gtt aaa gat ttt gcc    496
Leu Leu Ile Thr Gln Ala Cys Tyr Tyr Glu Lys Val Lys Asp Phe Ala
            125                 130                 135

cga gaa agt gat gtt aag gtc atg tgc gtg gac tct gcc ccg gac ggt    544
Arg Glu Ser Asp Val Lys Val Met Cys Val Asp Ser Ala Pro Asp Gly
        140                 145                 150

gct tca ctt ttc aga gct cac aca cag gca gac gaa aat gaa gtg cct    592
Ala Ser Leu Phe Arg Ala His Thr Gln Ala Asp Glu Asn Glu Val Pro
155                 160                 165                 170

cag gtc gac att agt cct gat gat gtc gta gca ttg cct tat tca tca    640
Gln Val Asp Ile Ser Pro Asp Asp Val Val Ala Leu Pro Tyr Ser Ser
                175                 180                 185

ggg act aca ggg ttg cca aaa ggg gtc atg tta acg cac aaa ggg cta    688
Gly Thr Thr Gly Leu Pro Lys Gly Val Met Leu Thr His Lys Gly Leu
            190                 195                 200

ata acc agt gtg gct caa cag gta gat gga gac aat cct aac ctg tat    736
Ile Thr Ser Val Ala Gln Gln Val Asp Gly Asp Asn Pro Asn Leu Tyr
            205                 210                 215

ttt cac agt gaa gat gtg att ctg tgt gtg ctt cct atg ttc cat atc    784
Phe His Ser Glu Asp Val Ile Leu Cys Val Leu Pro Met Phe His Ile
        220                 225                 230

tat gct ctg aat tca atg atg ctc tgt ggt ctg aga gtt ggt gcc tcg    832
Tyr Ala Leu Asn Ser Met Met Leu Cys Gly Leu Arg Val Gly Ala Ser
235                 240                 245                 250

att ttg ata atg cca aag ttt gag att ggt tct ttg ctg gga ttg att    880
Ile Leu Ile Met Pro Lys Phe Glu Ile Gly Ser Leu Leu Gly Leu Ile
                255                 260                 265

gag aag tac aag gta tct ata gca cca gtt gtt cca cct gtg atg atg    928
Glu Lys Tyr Lys Val Ser Ile Ala Pro Val Val Pro Pro Val Met Met
            270                 275                 280

gca att gct aag tca cct gat ctt gac aag cat gac ctg tct tct ttg    976
Ala Ile Ala Lys Ser Pro Asp Leu Asp Lys His Asp Leu Ser Ser Leu
            285                 290                 295

agg atg ata aaa tct gga ggg gct cca ttg ggc aag gaa ctt gaa gat    1024
Arg Met Ile Lys Ser Gly Gly Ala Pro Leu Gly Lys Glu Leu Glu Asp
        300                 305                 310
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act gtc aga gct aag ttt cct cag gct aga ctt ggt cag gga tat gga    1072
Thr Val Arg Ala Lys Phe Pro Gln Ala Arg Leu Gly Gln Gly Tyr Gly
315                 320             325                 330

atg acc gag gca gga cct gtt cta gca atg tgc ttg gca ttt gcc aag    1120
Met Thr Glu Ala Gly Pro Val Leu Ala Met Cys Leu Ala Phe Ala Lys
                    335             340             345

gaa cca ttc gac ata aaa cca ggt gca tgt gga act gta gtc agg aat    1168
Glu Pro Phe Asp Ile Lys Pro Gly Ala Cys Gly Thr Val Val Arg Asn
                350             355             360

gca gag atg aag att gtt gac cca gaa aca ggg gtc tct cta ccg agg    1216
Ala Glu Met Lys Ile Val Asp Pro Glu Thr Gly Val Ser Leu Pro Arg
            365             370             375

aac cag cct ggt gag atc tgc atc cgg ggt gat cag atc atg aaa gga    1264
Asn Gln Pro Gly Glu Ile Cys Ile Arg Gly Asp Gln Ile Met Lys Gly
        380             385             390

tat ctt aat gac ccc gag gca acc tca aga aca ata gac aaa gaa gga    1312
Tyr Leu Asn Asp Pro Glu Ala Thr Ser Arg Thr Ile Asp Lys Glu Gly
395                 400             405                 410

tgg ctg cac aca ggc gat atc ggc tac att gat gat gat gat gag ctt    1360
Trp Leu His Thr Gly Asp Ile Gly Tyr Ile Asp Asp Asp Asp Glu Leu
                415             420             425

ttc atc gtt gac aga ttg aag gaa ttg atc aag tat aaa ggg ttt cag    1408
Phe Ile Val Asp Arg Leu Lys Glu Leu Ile Lys Tyr Lys Gly Phe Gln
                430             435             440

gtt gct cct act gaa ctc gaa gct ttg tta ata gcc cat cca gag ata    1456
Val Ala Pro Thr Glu Leu Glu Ala Leu Leu Ile Ala His Pro Glu Ile
            445             450             455

tcc gat gct gct gta gta gga ttg aaa gat gag gat gcg gga gaa gtt    1504
Ser Asp Ala Ala Val Val Gly Leu Lys Asp Glu Asp Ala Gly Glu Val
        460             465             470

cct gtt gca ttt gta gtg aaa tca gaa aag tct cag gcc acc gaa gat    1552
Pro Val Ala Phe Val Val Lys Ser Glu Lys Ser Gln Ala Thr Glu Asp
475                 480             485                 490

gaa att aag cag tat att tca aaa cag gtg atc ttc tac aag aga ata    1600
Glu Ile Lys Gln Tyr Ile Ser Lys Gln Val Ile Phe Tyr Lys Arg Ile
                495             500             505

aaa cga gtt ttc ttc att gaa gca att ccc aag gca cca tca ggc aag    1648
Lys Arg Val Phe Phe Ile Glu Ala Ile Pro Lys Ala Pro Ser Gly Lys
                510             515             520

atc ctg agg aag aat ctg aaa gag aag ttg cca ggc ata taactgaaga    1697
Ile Leu Arg Lys Asn Leu Lys Glu Lys Leu Pro Gly Ile
            525             530             535
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3 43

A

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tgttactgaa catttaaccc tctgtcttat ttctttaata cttgcgaatc attgtagtgt    1757
tgaaccaagc atgcttggaa aagacacgta cccaacgtaa gacagttact gttcctagta    1817
tacaagctct ttaatgttcg ttttgaactt gggaaaacat aagttctcct gtcgccatat    1877
ggagtaattc aattgaatat tttggtttct ttaatgat                           1915
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<213> Populus tremuloides Michx. (aspen)

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                20                  25                  30
Lys His Ser Ser Lys Pro Cys Leu Ile Asn Gly Ala Asn Gly Asp Val
            35                  40                  45
Tyr Thr Tyr Ala Asp Val Glu Leu Thr Ala Arg Arg Val Ala Ser Gly
        50                  55                  60
Leu Asn Lys Ile Gly Ile Gln Gln Gly Asp Val Ile Met Leu Phe Leu
65                  70                  75                  80
Pro Ser Ser Pro Glu Phe Val Leu Ala Phe Leu Gly Ala Ser His Arg
                85                  90                  95
Gly Ala Met Ile Thr Ala Ala Asn Pro Phe Ser Thr Pro Ala Glu Leu
            100                 105                 110
Ala Lys His Ala Lys Ala Ser Arg Ala Lys Leu Leu Ile Thr Gln Ala
            115                 120                 125
Cys Tyr Tyr Glu Lys Val Lys Asp Phe Ala Arg Glu Ser Asp Val Lys
        130                 135                 140
Val Met Cys Val Asp Ser Ala Pro Asp Gly Ala Ser Leu Phe Arg Ala
145                 150                 155                 160
His Thr Gln Ala Asp Glu Asn Glu Val Pro Gln Val Asp Ile Ser Pro
                165                 170                 175
Asp Asp Val Val Ala Leu Pro Tyr Ser Ser Gly Thr Thr Gly Leu Pro
            180                 185                 190
Lys Gly Val Met Leu Thr His Lys Gly Leu Ile Thr Ser Val Ala Gln
            195                 200                 205
Gln Val Asp Gly Asp Asn Pro Asn Leu Tyr Phe His Ser Glu Asp Val
        210                 215                 220
Ile Leu Cys Val Leu Pro Met Phe His Ile Tyr Ala Leu Asn Ser Met
225                 230                 235                 240
Met Leu Cys Gly Leu Arg Val Gly Ala Ser Ile Leu Ile Met Pro Lys
                245                 250                 255
Phe Glu Ile Gly Ser Leu Leu Gly Leu Ile Glu Lys Tyr Lys Val Ser
            260                 265                 270
Ile Ala Pro Val Val Pro Pro Val Met Met Ala Ile Ala Lys Ser Pro
            275                 280                 285
Asp Leu Asp Lys His Asp Leu Ser Ser Leu Arg Met Ile Lys Ser Gly
        290                 295                 300
Gly Ala Pro Leu Gly Lys Glu Leu Glu Asp Thr Val Arg Ala Lys Phe
305                 310                 315                 320
Pro Gln Ala Arg Leu Gly Gln Gly Tyr Gly Met Thr Glu Ala Gly Pro
                325                 330                 335
Val Leu Ala Met Cys Leu Ala Phe Ala Lys Glu Pro Phe Asp Ile Lys
            340                 345                 350
Pro Gly Ala Cys Gly Thr Val Val Arg Asn Ala Glu Met Lys Ile Val
```

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        355                    360                    365
Asp Pro Glu Thr Gly Val Ser Leu Pro Arg Asn Gln Pro Gly Glu Ile
        370                    375                    380
Cys Ile Arg Gly Asp Gln Ile Met Lys Gly Tyr Leu Asn Asp Pro Glu
385                    390                    395                    400
Ala Thr Ser Arg Thr Ile Asp Lys Glu Gly Trp Leu His Thr Gly Asp
        Ile Gly Tyr Ile Asp Asp Asp Asp Glu Leu Phe Ile Val Asp Arg Leu
                        405                    410                    415
Ile Gly Tyr Ile Asp Asp Asp Asp Glu Leu Phe Ile Val Asp Arg Leu
                        420                    425                    430
Lys Glu Leu Ile Lys Tyr Lys Gly Phe Gln Val Ala Pro Thr Glu Leu
                        435                    440                    445
Glu Ala Leu Leu Ile Ala His Pro Glu Ile Ser Asp Ala Ala Val Val
        450                    455                    460
Gly Leu Lys Asp Glu Asp Ala Gly Glu Val Pro Val Ala Phe Val Val
465                    470                    475                    480
Lys Ser Glu Lys Ser Gln Ala Thr Glu Asp Glu Ile Lys Gln Tyr Ile
                        485                    490                    495
Ser Lys Gln Val Ile Phe Tyr Lys Arg Ile Lys Arg Val Phe Phe Ile
                        500                    505                    510
Glu Ala Ile Pro Lys Ala Pro Ser Gly Lys Ile Leu Arg Lys Asn Leu
                        515                    520                    525
Lys Glu Lys Leu Pro Gly Ile
        530                    535
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(Note: the line "Ile Gly Tyr Ile Asp Asp Asp Asp Glu Leu Phe Ile Val Asp Arg Leu" appears corrected above.)

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        <213>  Populus tremuloides Michx. (aspen)

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 1               5                  10                  15

cca caa aac caa aac gca cca tcc tct cat gaa act gat cac att ttc        96
Pro Gln Asn Gln Asn Ala Pro Ser Ser His Glu Thr Asp His Ile Phe
                20                  25                  30

aga tca aaa cta cca gac ata acc atc tcg aac gac ctc cct ctg cac       144
Arg Ser Lys Leu Pro Asp Ile Thr Ile Ser Asn Asp Leu Pro Leu His
            35                  40                  45

gca tac tgc ttt gaa aac ctc tct gat ttc tca gat agg cca tgc ttg       192
Ala Tyr Cys Phe Glu Asn Leu Ser Asp Phe Ser Asp Arg Pro Cys Leu
        50                  55                  60

att tca ggt tcc acg gga aaa acc tat tct ttt gcc gaa act cac ctc       240
Ile Ser Gly Ser Thr Gly Lys Thr Tyr Ser Phe Ala Glu Thr His Leu
65                  70                  75                  80

ata tct cgg aag gtc gct gct ggg tta tcc aat ttg ggc atc aag aaa       288
Ile Ser Arg Lys Val Ala Ala Gly Leu Ser Asn Leu Gly Ile Lys Lys
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5   45

A

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ggc gat gta atc atg acc ctg ctc caa aac tgc cca gaa ttc gtc ttc      336
Gly Asp Val Ile Met Thr Leu Leu Gln Asn Cys Pro Glu Phe Val Phe
        100             105             110

tcc ttc atc ggt gct tcc atg att ggt gca gtc atc acc act gcg aac      384
Ser Phe Ile Gly Ala Ser Met Ile Gly Ala Val Ile Thr Thr Ala Asn
        115             120             125

cct ttc tac act caa agt gaa ata ttc aag caa ttc tct gct tct cgt      432
Pro Phe Tyr Thr Gln Ser Glu Ile Phe Lys Gln Phe Ser Ala Ser Arg
        130             135             140

gcg aaa ctg att atc acc cag tct caa tat gtg aac aag cta gga gat      480
Ala Lys Leu Ile Ile Thr Gln Ser Gln Tyr Val Asn Lys Leu Gly Asp
145                 150             155                 160

agt gat tgc cat gaa aac aac caa aaa ccg ggg gaa gat ttc ata gta      528
Ser Asp Cys His Glu Asn Asn Gln Lys Pro Gly Glu Asp Phe Ile Val
                165             170             175

atc acc att gat gac ccg cca gag aac tgt cta cat ttc aat gtg ctt      576
Ile Thr Ile Asp Asp Pro Pro Glu Asn Cys Leu His Phe Asn Val Leu
                180             185             190

gtc gag gct agc gag agt gaa atg cca aca gtt tca atc ctt ccg gat      624
Val Glu Ala Ser Glu Ser Glu Met Pro Thr Val Ser Ile Leu Pro Asp
        195             200             205

gat cct gtg gca tta cca ttc tct tca ggg aca aca ggg ctc cca aaa      672
Asp Pro Val Ala Leu Pro Phe Ser Ser Gly Thr Thr Gly Leu Pro Lys
        210             215             220

gga gtg ata ctg acc cac aag agc ttg ata aca agt gtg gct caa caa      720
Gly Val Ile Leu Thr His Lys Ser Leu Ile Thr Ser Val Ala Gln Gln
225                 230             235                 240

gtt gat gga gag atc cca aat tta tac ttg aaa caa gat gac gtt gtt      768
Val Asp Gly Glu Ile Pro Asn Leu Tyr Leu Lys Gln Asp Asp Val Val
                245             250             255

tta tgc gtt tta cct ttg ttt cac atc ttt tca ttg aac agc gtg ttg      816
Leu Cys Val Leu Pro Leu Phe His Ile Phe Ser Leu Asn Ser Val Leu
        260             265             270

tta tgc tcg ttg aga gcc ggt tct gct gtt ctt tta atg caa aag ttt      864
Leu Cys Ser Leu Arg Ala Gly Ser Ala Val Leu Leu Met Gln Lys Phe
        275             280             285

gag ata gga tca ctg cta gag ctc att cag aaa cac aat gtt tcg gtt      912
Glu Ile Gly Ser Leu Leu Glu Leu Ile Gln Lys His Asn Val Ser Val
        290             295             300

gcg gct gtg gtg cca cca ctg gtg ctg gcg ttg gcc aag aac cca ttg      960
Ala Ala Val Val Pro Pro Leu Val Leu Ala Leu Ala Lys Asn Pro Leu
305                 310             315                 320
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A

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gag gcg aac ttc gac ttg agt tcg atc agg gta gtc ctg tca ggg gct    1008
Glu Ala Asn Phe Asp Leu Ser Ser Ile Arg Val Val Leu Ser Gly Ala
            325             330             335

gcg cca ctg ggg aag gag ctc gag gac gcc ctc agg agc agg gtt cct    1056
Ala Pro Leu Gly Lys Glu Leu Glu Asp Ala Leu Arg Ser Arg Val Pro
            340             345             350

cag gcc atc ctg gga cag ggt tat ggg atg aca gag gcc ggg cct gtg    1104
Gln Ala Ile Leu Gly Gln Gly Tyr Gly Met Thr Glu Ala Gly Pro Val
            355             360             365

cta tca atg tgc tta gcc ttt tca aag caa cct ttc cca acc aag tct    1152
Leu Ser Met Cys Leu Ala Phe Ser Lys Gln Pro Phe Pro Thr Lys Ser
            370             375             380

ggg tcg tgt gga acg gtg gtt aga aac gca gag ctc aag gtc att gac    1200
Gly Ser Cys Gly Thr Val Val Arg Asn Ala Glu Leu Lys Val Ile Asp
385             390             395             400

cct gag acc ggt cgc tct ctt ggt tac aac caa cct ggt gaa atc tgc    1248
Pro Glu Thr Gly Arg Ser Leu Gly Tyr Asn Gln Pro Gly Glu Ile Cys
            405             410             415

atc cgt gga tcc caa atc atg aaa gga tat ttg aat gac gcg gaa gcc    1296
Ile Arg Gly Ser Gln Ile Met Lys Gly Tyr Leu Asn Asp Ala Glu Ala
            420             425             430

acg gca aac acc ata gac gtt gag ggt tgg ctc cac act gga gat ata    1344
Thr Ala Asn Thr Ile Asp Val Glu Gly Trp Leu His Thr Gly Asp Ile
            435             440             445

ggt tat gtc gac gac gac gac gag att ttc att gtt gat aga gtg aag    1392
Gly Tyr Val Asp Asp Asp Asp Glu Ile Phe Ile Val Asp Arg Val Lys
            450             455             460

gaa atc ata aaa ttc aaa ggc ttc cag gtg ccg cca gcg gag ctt gag    1440
Glu Ile Ile Lys Phe Lys Gly Phe Gln Val Pro Pro Ala Glu Leu Glu
465             470             475             480

gct ctc ctt gta aac cac cct tca att gcg gat gcg gct gtt gtt ccg    1488
Ala Leu Leu Val Asn His Pro Ser Ile Ala Asp Ala Ala Val Val Pro
            485             490             495

caa aaa gac gag gtt gct ggt gaa gtt cct gtc gcg ttt gtg gtc cgc    1536
Gln Lys Asp Glu Val Ala Gly Glu Val Pro Val Ala Phe Val Val Arg
            500             505             510

tca gat gat ctt gac ctt agt gaa gag gct gta aaa gaa tac att gca    1584
Ser Asp Asp Leu Asp Leu Ser Glu Glu Ala Val Lys Glu Tyr Ile Ala
            515             520             525

aag cag gtg gtg ttc tac aag aaa ctg cac aag gtg ttc ttc gtt cat    1632
Lys Gln Val Val Phe Tyr Lys Lys Leu His Lys Val Phe Phe Val His
            530             535             540
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7

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tct att ccc aaa tcg gct tct gga aag att cta aga aaa gac ctc aga          1680
Ser Ile Pro Lys Ser Ala Ser Gly Lys Ile Leu Arg Lys Asp Leu Arg
545                 550             555                 560

gcc aag ctt gcc aca gcc acc acc atg tcc                                  1710
Ala Lys Leu Ala Thr Ala Thr Thr Met Ser
                565                 570


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        <211> 570
        <212> PRT
        <213> Populus tremuloides Michx. (aspen)


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Met Met Ser Val Ala Thr Val Glu Pro Pro Lys Pro Glu Leu Ser Pro
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Pro Gln Asn Gln Asn Ala Pro Ser Ser His Glu Thr Asp His Ile Phe
                20              25              30
Arg Ser Lys Leu Pro Asp Ile Thr Ile Ser Asn Asp Leu Pro Leu His
            35              40              45
Ala Tyr Cys Phe Glu Asn Leu Ser Asp Phe Ser Asp Arg Pro Cys Leu
        50              55              60
Ile Ser Gly Ser Thr Gly Lys Thr Tyr Ser Phe Ala Glu Thr His Leu
65              70              75              80
Ile Ser Arg Lys Val Ala Ala Gly Leu Ser Asn Leu Gly Ile Lys Lys
            85              90              95
Gly Asp Val Ile Met Thr Leu Leu Gln Asn Cys Pro Glu Phe Val Phe
            100             105             110
Ser Phe Ile Gly Ala Ser Met Ile Gly Ala Val Ile Thr Thr Ala Asn
        115             120             125
Pro Phe Tyr Thr Gln Ser Glu Ile Phe Lys Gln Phe Ser Ala Ser Arg
        130             135             140
Ala Lys Leu Ile Ile Thr Gln Ser Gln Tyr Val Asn Lys Leu Gly Asp
145             150             155             160
Ser Asp Cys His Glu Asn Asn Gln Lys Pro Gly Glu Asp Phe Ile Val
            165             170             175
Ile Thr Ile Asp Asp Pro Pro Glu Asn Cys Leu His Phe Asn Val Leu
            180             185             190
Val Glu Ala Ser Glu Ser Glu Met Pro Thr Val Ser Ile Leu Pro Asp
        195             200             205
Asp Pro Val Ala Leu Pro Phe Ser Ser Gly Thr Thr Gly Leu Pro Lys
    210             215             220
Gly Val Ile Leu Thr His Lys Ser Leu Ile Thr Ser Val Ala Gln Gln
225             230             235             240
Val Asp Gly Glu Ile Pro Asn Leu Tyr Leu Lys Gln Asp Asp Val Val
            245             250             255
Leu Cys Val Leu Pro Leu Phe His Ile Phe Ser Leu Asn Ser Val Leu
            260             265             270
Leu Cys Ser Leu Arg Ala Gly Ser Ala Val Leu Leu Met Gln Lys Phe
        275             280             285
Glu Ile Gly Ser Leu Leu Glu Leu Ile Gln Lys His Asn Val Ser Val
        290             295             300
Ala Ala Val Val Pro Pro Leu Val Leu Ala Leu Ala Lys Asn Pro Leu
305             310             315             320
Glu Ala Asn Phe Asp Leu Ser Ser Ile Arg Val Val Leu Ser Gly Ala
            325             330             335
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8

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Ala Pro Leu Gly Lys Glu Leu Glu Asp Ala Leu Arg Ser Arg Val Pro
            340                     345                 350
Gln Ala Ile Leu Gly Gln Gly Tyr Gly Met Thr Glu Ala Gly Pro Val
            355                     360                 365
Leu Ser Met Cys Leu Ala Phe Ser Lys Gln Pro Phe Pro Thr Lys Ser
            370                     375                 380
Gly Ser Cys Gly Thr Val Val Arg Asn Ala Glu Leu Lys Val Ile Asp
385                     390                     395                 400
Pro Glu Thr Gly Arg Ser Leu Gly Tyr Asn Gln Pro Gly Glu Ile Cys
                    405                 410   ·                 415
Ile Arg Gly Ser Gln Ile Met Lys Gly Tyr Leu Asn Asp Ala Glu Ala
                    420                 425                 430
Thr Ala Asn Thr Ile Asp Val Glu Gly Trp Leu His Thr Gly Asp Ile
            435                     440                 445
Gly Tyr Val Asp Asp Asp Asp Glu Ile Phe Ile Val Asp Arg Val Lys
            450                     455                 460
Glu Ile Ile Lys Phe Lys Gly Phe Gln Val Pro Pro Ala Glu Leu Glu
465                     470                     475                 480
Ala Leu Leu Val Asn His Pro Ser Ile Ala Asp Ala Ala Val Val Pro
                    485                 490                 495
Gln Lys Asp Glu Val Ala Gly Glu Val Pro Val Ala Phe Val Val Arg
                    500                 505                 510
Ser Asp Asp Leu Asp Leu Ser Glu Glu Ala Val Lys Glu Tyr Ile Ala
            515                     520                 525
Lys Gln Val Val Phe Tyr Lys Lys Leu His Lys Val Phe Phe Val His
            530                     535                 540
Ser Ile Pro Lys Ser Ala Ser Gly Lys Ile Leu Arg Lys Asp Leu Arg
545                     550                     555                 560
Ala Lys Leu Ala Thr Ala Thr Thr Met Ser
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    <212> DNA
    <213> Populus tremuloides Michx. (aspen)

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atggctatga tgaaggttaa tagaggtagt tgtgattgag atatgtccag cactagtttt   180
ttgttggtgt gatttctcat gatgacgcga aaattttata tatatatata atgaataata   240
tgattgatta ttctctgtaa ttttgtgaaa tagattaaaa cagctcaatg tgaggtgacc   300
agttgtcaaa tgaccactcg acttggggca tggtgatttt tcaaatcaca actcaatttg   360
aaaactaaaa ttaaaaaaga tttagattat taaattatta ggttaattca cgggttggct   420
aatcaattat tattaattaa aacgatagta tttttgataa tttaattaaa attttattgg   480
atttgaatga actcaattac atcacaaaaa acctaatcaa attaatatct tatgtgatat   540
aatttagaaa tataaatgat taacctttaa atctcgagtt tctcttataa aaaacacgta   600
taattgggct agatttaaca gctattattc aaactggcca ggacaattat taaaattaat   660
aattattatt ttttctaata aagcacttcc taattgttaa aatatatgtc taaacactaa   720
taataaaatt tatttgtgta tctttggcag taggtgagag gtgctgacaa ataaattagt   780
gcataaaata taatggattg gtggtctgtg aaaagacagg tggaggacaa gccacctctc   840
tcaagtcaaa aggccatttc acaaccaacc caaatgggaa cccaccaccg ttccccgcca   900
ttaaaatccc taatctcacc aacccaactc cacagattct tcaccaaacg caactgattt   960
ttcaatcaat gttttcccta tactaccccc ccaacaactc cataataccc aatttgtcct  1020
ttcaccaacc cccgtcctcc gtgccagcca attctatatc agcaggaatg ctctgcactc  1080
tgctttctca ggtctcctac cataagaaaa cagagagcac ctaaaactcg ccatctctcc  1140
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tattttttta aaaatttaaa aattaaatta taacattttt attttatccc tcattaacta   180
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ctattttgat atttataccc tactcattac ttatggaata aaaaatttag atatttataa   300
aatatttatc ggatttcagg tattcatatg aatatttatt tgattattat ttattcaaca   360
aaaaataaaa caattaatat gcatgtttga agtttatata tatattaagt taggtttaga   420
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<210> 7
<211> 12
<212> PRT
<213> Populus tremuloides Michx. (aspen)

<400> 7
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<210> 8
<211> 7
<212> PRT
<213> Populus tremuloides Michx. (aspen)

<400> 8
Gly Glu Ile Cys Ile Arg Gly
 1   5

<210> 9
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<212> DNA
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<222> (11)
<223> n represents inosine

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A

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<210> 16
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<210> 17
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